INDOOR AIR QUALITY ASSESSMENT

Melrose Veterans Memorial Middle School
350 Lynn Fells Parkway
Melrose, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Ruth Clay, Director of the Melrose Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Melrose Veterans Memorial Middle School (MVMMS), 350 Lynn Fells Parkway, Melrose, Massachusetts.

On March 26, 2002 and April 23, 2002, visits were made to this school by Cory Holmes and Suzan Donahue, of BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program, to conduct an indoor air quality assessment. BEHA staff were accompanied by Ms. Kristin McRae of the Melrose Health Department during the assessment.

The school is a four-story brick building originally constructed as a high school in 1932. A separate three-floor annex building was added in the late 1950's, which is connected to the original building by an elevated walkway "bridge". The school currently houses grades 6-8.

The first floor is partially below grade, and contains the cafeteria, kitchen, teachers' dining room, shops, locker rooms, custodial offices and the boiler room. The second floor contains the auditorium, gymnasium, offices, computer rooms, and general classrooms. The third and fourth floors of the main building consist primarily of general classrooms. The annex building primarily contains general classrooms, with two art rooms located on the third floor. The first floor of the annex building is currently leased from the City of Melrose by a private agency, and is reportedly being used as classrooms for students with special needs.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

This school has a student population of over 800 and a staff of approximately 95. Tests were taken during normal operations at the school and results appear in Tables 1-13.

Discussion

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in forty-five out of forty-six areas surveyed on March 26, 2002 and in thirty-six out of fifty areas on April 23, 2002. These measurements indicate an overall ventilation problem in the school. All areas tested in the annex building and the third and fourth floors of the main building had elevated carbon dioxide levels, some without occupancy and/or with open windows and doors, both of which can greatly reduce carbon dioxide levels. Of note was room 307, which had a carbon dioxide level of over 3,000 ppm with a window open, indicating little/no air exchange.

Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents appear to be original equipment., Equipment of this age can be difficult to maintain due to unavailability of replacement parts. Most of the univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air

through an air intake located at the base of each unit (see Figure 1). Univents for a number of fourth floor classrooms (401, 402, 413, 414, 415, 416, 417 & 418) are ducted to an intake vent on a rooftop penthouse (see Pictures 1 & 2). Instead of drawing air directly into the unit from the exterior wall, air has to be drawn into the intake vent on top of the penthouse, through long stretches of ductwork, which reduces the efficiency of the unit to introduce fresh air to the interior of classrooms. The return vents on the older model univents of the main building are located on the side of each unit. Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents were found deactivated in classrooms throughout the school on both days of the assessment.

Obstructions to airflow, such as papers and books stored on univents and bookcases as well as carts and desks in front of univent returns, were seen in a number of classrooms. In order for univents to provide fresh air as designed, intakes must remain free of obstructions and importantly; these units must remain "on" and allowed to operate while rooms are occupied. Fresh air diffusers and heating fins of many univents were damaged (see Picture 3). Several univents were also found to have accumulated dirt/debris. These univents should be cleaned before operating to prevent aerosolization of this material.

Of note were univents located in ground floor classrooms along the front (south-facing) exterior wall of the MVMMS. Univent fresh air intakes were sealed with plywood (see Picture 4), effectively preventing fresh air distribution into these classrooms. Without fresh outdoor air to temper return air from classrooms, temperature control in these classrooms would be expected to be difficult.

Exhaust ventilation in classrooms with univents is provided by a mechanical system. The exhaust system in each classroom consists of ducted, grated wall vents. A number of exhaust vents were obstructed by tables, chairs, boxes and other items (see Picture 5). Little or no draw of air was detected in many classrooms (see Tables), which can indicate that either the exhaust ventilation was turned off, or that rooftop motors were not functioning. BEHA staff visited the roof during both visits and found rooftop exhaust motors deactivated. As with the univents, in order for exhaust ventilation to function as designed, vents must be activated and remain free of obstructions. Without removal by exhaust ventilation, normally occurring environmental pollutants can build up and lead to indoor air complaints.

In order to have proper ventilation with a univent and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. According to school department officials, the date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

On both days of testing, temperatures were below the BEHA comfort range in over half of the classrooms tested. Temperature readings ranged from 65^{o} F to 73^{o} F on March 26, 2002 and from 64^{o} F to 71^{o} F on April 23, 2002. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. A number of temperature control/comfort complaints were expressed throughout the building. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. In addition, it is difficult to control

temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents deactivated, exhaust vents obstructed/not operating). While temperature readings outside the recommended range are generally not a health concern, increased temperature can affect the relative humidity in a building.

The relative humidity in the building was below the BEHA recommended comfort range in some areas sampled. Relative humidity measurements ranged from 27 to 40 percent on March 26, 2002 and from 30 to 46 percent on April 23, 2002. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Humidity is more difficult to control during the winter heating season. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

While the relative humidity range within the building was below the BEHA comfort range, the measurements taken during the April 23, 2002 sampling indicate that a moisture source exists within the school. Under normal circumstances, increased temperature within a building will serve to lower the relative humidity of air introduced by the ventilation system. During the April 23, 2002 air monitoring, the relative humidity ***was increased*** over outdoor measurements, despite higher indoor temperature compared to that outdoors (see Tables). Of note is that relative humidity measured indoors exceeded outdoor measurements (range +1-11 percent). The increase in relative humidity can indicate that the exhaust system is not operating sufficiently to remove normal indoor air pollutants (e.g., water vapor from respiration). It may also indicate that a moisture source beyond that produced by occupant respiration exist within the building (see the Microbial/Moisture Concerns section). Removal of moisture from the air

through the use of dehumidifiers, however, can have some negative effects. The sensation of dryness and irritation is common in a low relative humidity environment

Microbial/Moisture Concerns

The school has a history of flooding problems. Along the edge of the foundation of the building are a series of holes that are a minimum, three feet below ground level (see Pictures 6 &7). These holes appear to be signs of water draining beneath the foundation. These types of holes can be created by water scouring the soil, as it drains towards the building. Scouring is the removal of soil by moving water during erosion. In addition, the holes showed signs of subsidence, leaving behind water-filled holes against/under the foundation. Subsidence is caused by either compaction of organic soils as the ground/fill settles or when materials (e.g. water) are withdrawn from under the ground, causing the land surface to sink (FEMA, 1987). There appear to be several factors that contribute to this condition.

1. The school was built on land that is near the level of Ell Pond according to a topographical map of this area (see Map 1/Picture 8).
2. The water table in the area surrounding the building is relatively high. A wetland exists to the southwest of the MVMMS. Water was noted within the wetland, in spite of drought conditions in Massachusetts and lack of rainfall several days prior to these observations on August 8, 2002. The level of water in the wetland is estimated to be three feet below the grade at the MVMMS foundation. This water level matches the water level observed in a storm drain on the street in front of the MVMMS. Standing

water was also noted on the boiler room floor (see Picture 9), which is at the lowest level of the MVMMS.

3. A concrete walkway was installed along the outer edge of the driveway that leads to the front door of the MVMMS. The walkway is at a ***higher level*** than the ground between this walkway and the foundation. This configuration would prevent water accumulating along the edge of the MVMMS from draining. In essence, the concrete walkway serves as a dam to hold water against the foundation. Without proper pitch and pathways, the only available route for water to drain from the edge of the foundation is under the foundation, through the holes in Pictures 6 & 7.
4. Water will tend to accumulate on the southern side of the building due to weather conditions in New England. Moist weather tends to travel in a northeasterly track up the Atlantic Coast towards New England (Trewartha, G.T., 1943). Wet weather systems generally produce south/southwesterly winds, which will tend to deliver driving rain to the south/southwestern/western walls of the MVMMS.
5. In contrast, the adjacent high school is constructed in a manner to have the ground floor several feet above ground level, which would serve to prevent flooding at times of high groundwater level and/or flooding of Ell Pond (see Map 2).

Water and accumulated debris were observed under the foundation of the MVMMS building. Chronic flooding in a building can lead to microbial growth. Standing water can become stagnant, which can lead to bacterial or microbial growth that can be sources of unpleasant odors. Mold particulate can penetrate though utility holes and into occupied areas. Although no odors/mold growth were noted at the time of the assessment, the potential exists once water drains below the foundation. Since this

evaluation was done during drought conditions, the groundwater levels surrounding the building may be significantly higher during periods of normal rainfall.

In addition to standing water, subsistence of soil beneath the foundation of the MVMMS can lead to uneven settling of parts of the foundation. The stress on various components of the building structure can lead to cracking of exterior walls, floors and window casements, which in turn can lead to water penetration into the interior of the building. Since the holes shown in Pictures 6 & 7 are located on the southern wall of the MVMMS, uneven settling would be expected to occur in these sections of the building. A number of areas throughout the building had wall cracks due to settling and/or showed signs of efflorescence (see Pictures 10 & 11). Efflorescence is a characteristic sign of water damage to building materials, but it is not mold growth. As moisture penetrates and works its way through building materials, water-soluble compounds dissolve, creating a solution. As this solution moves to the surface, the water evaporates, leaving behind white, powdery mineral deposits. Water-damaged building materials, if wetted repeatedly, can also be a medium for mold growth.

A number of rooms had water-stained ceiling tiles, which are evidence of historic wall, roof or plumbing leaks (see Picture 12). Water-damaged ceiling tiles can also provide a source of microbial growth and should be replaced after a water leak is discovered. A particular area of heavy water damage is the enclosed walkway connecting the main building to the annex.

Other conditions were noted that may allow for water to penetrate into the building. Shrubbery was noted growing within close proximity or in contact with exterior walls (see Picture 13). In addition, the growth of roots against the exterior walls

can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek, J. & Brennan, T.; 2001).

Throughout the school, caulking around the interior and exterior windowpanes was crumbling, missing or damaged (see Pictures 14 & 15). Several rooms contained loose fitting windowpanes and/or cracked or broken windows. Air infiltration was noted around windows. Many areas had water damaged wall plaster and other building materials, which most likely resulted in chronic water penetration through improperly sealed windows. Water penetration through window frames can lead to mold growth under certain conditions. Repairs of window leaks are necessary to prevent further water penetration. Repeated water damage can result in mold colonization of window frames, curtains and items stored on or near windowsills.

Standing water and accumulated debris was noted in a number of areas on the roof. In particular, on the lower roof of the main building, a trough is formed between the exterior wall and the univent penthouse (see Picture 16). The collection of water and its subsequent freezing and thawing during winter months can lead to roof leaks resulting in water penetration into the interior of the building. Pooling water can also become stagnant, which can lead to mold and bacterial growth, resulting in unpleasant odors and providing a breeding ground for mosquitoes in warmer months.

Several classrooms contained a number of plants. Plant soil and drip pans can serve as a source of mold growth. Plants should be located away from univents and

exhaust ventilation to prevent aerosolization of dirt, pollen or mold. Room 314 contained an aquarium with standing water. When not in use, aquariums should be properly cleaned to prevent microbial growth and nuisance odors.

Occupants also reported an historic problem with roosting of birds, primarily within rooftop ventilation equipment. Bird wastes in a building raise health concerns and warrant appropriate clean up/disinfection. Bird waste accumulated inside buildings is a public health concern since it can be a source of pathogens that may infect sensitive individuals. Fungi (molds) are associated with bird waste. While this particular mold has been found to be problematic with immune compromised patients, other diseases of the respiratory tract can also result from exposure to bird waste. Exposure to bird wastes are thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) and histoplasmosis are diseases closely associated with exposure to bird wastes in either the occupational or bird raising settings. While immune compromised individuals have an increased risk of exposure to the materials in bird waste, the diseases aforementioned may occur in healthy individuals exposed to these materials.

At the time of the BEHA assessment, pigeon wastes had reportedly been cleaned and screens were installed on rooftop exhaust motors to prevent bird egress. BEHA staff conducted an inspection of the rooftop ventilation components for evidence of bird wastes/roosting. At the time of our inspection, BEHA staff observed no evidence of further roosting of birds within rooftop ventilation equipment. Exhaust vents were outfitted with wire screens attached to the vent housing to allow airflow and prevent the egress of pigeons. In most cases screens were fit flush or close to the housing of the vent

opening (see Picture 17), however in several instances spaces of 1-2 inches were noted between the screens and vent housing (see Picture 18).

Other Concerns

Several other conditions were noted during the assessment which can affect indoor air quality. Strong odors, presumably emanating from the woodshop, were detected on the first floor in the handicapped stairwell. The woodshop (located on the ground floor) had large spaces between its double doors. These spaces can allow odors and dust to penetrate into the hallway and adjacent areas. The woodshop has local exhaust ventilation for wood cutting/sanding machines ducted to a wood dust collector. The wood dust collector is not ducted to the outdoors. Since the wood dust collector is not designed to filter small diameter particles, the use of this machine without ducting outdoors may aerosolize wood dust to make it more readily inhaled. Excessive amounts of wood dust on flat surfaces indicate that wood dust aerosolization is occurring. Wood dust can be irritating to the eyes, nose, throat and respiratory system.

Also noted in the woodshop and in adjacent rooms currently used for storage, were cans of shellacs, wood finishers and paint thinners (see Picture 19). Several cans in this area appear to be corroded, which can lead to container failure (see Picture 20). These products contain volatile organic compounds (VOCs), which evaporate readily and be irritating to eyes, nose and throat. These products are flammable as well, and should be stored in a cabinet, which meets the criteria set forth by the National Fire Protection Association (NFPA) (NFPA, 1996).

The following conditions noted in chemical storage rooms in science areas can have an adverse affect on air quality.

- Bottles of acids were stored in close proximity to alkaline materials (bleach).
- Crystallized spillage from unknown chemicals was coating the interior of the flammable cabinet. The interior of the cabinet has begun to corrode from exposure to off-gassing chemicals (see Picture 21).
- Flasks containing chemicals were sealed with plastic or glass stoppers, which can lead to the slow evaporation of materials from these containers.
- Some bottles were missing labels.
- Flasks filled with chemicals are labeled by chemical formula and not name.
- Chemicals in the storeroom are stored on shelves without any barriers/guardrails to prevent bottles from falling.

It is highly recommended that a thorough inventory of chemicals in the science department be done to assess chemical storage and disposal in an appropriate manner consistent with Massachusetts hazardous waste laws.

The art room of the annex building contains an unused pottery kiln, located next to the univent (see Picture 22). The exterior of the kiln is corroded, exposing a crumbling material (see Picture 23). Pottery kilns may contain insulation in the roof and wall cavities, which can contain asbestos (HSE, 1996). It should be determined if this material has been tested for asbestos in accordance with the school's asbestos hazard emergency response act (AHERA) management plan. It would also be advisable to relocate the kiln away from the univent.

Wall cracks, utility holes, and missing/dislodged ceiling tiles were noted in a number of areas throughout the building. Open utility holes can provide a means of egress for odors, fumes, dusts and vapors between rooms and floors. The missing/dislodged ceiling tiles can introduce dirt, dust and particulate matter into occupied areas of the school. These materials can be irritating to certain individuals.

The main office and teachers' lounges have photocopiers. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). The main office photocopier area has no local exhaust ventilation to help reduce excess heat and odors.

Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Also of note was the amount of materials stored inside classrooms (see Picture 24). In classrooms throughout the school, items were seen piled on windowsills, tabletops, counters, bookcases and desks. The large amount of items stored in classrooms provides a means for dusts, dirt and other potential respiratory irritants to accumulate. These items, (e.g., papers, folders, boxes, etc.) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract. These items should be relocated and/or cleaned periodically to avoid excessive dust build up. In addition, a number of exhaust vents in classrooms were noted with accumulated dust. If exhaust

vents are not functioning, backdrafting can occur, which can re-aerosolize accumulated dust particles.

Finally, a number of restroom exhaust vents were either not operating, drawing weakly or sealed with sheet metal or clogged with debris (see Pictures 25 & 26). Exhaust ventilation is necessary in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

Conclusions/Recommendations

The conditions noted at the MVMMS raise a number of indoor air quality issues. The combination of the general building conditions, maintenance, design and the operation (or lack) of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. The ultimate deposition of water beneath this building and its drainage need to be studied to prevent further damage to the building envelope. For these reasons, a two-phase approach is required consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address overall indoor air quality concerns.

The following **short-term** measures should be considered for implementation:

1. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
2. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Operate fresh air supply univents while classrooms are occupied. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
3. Regularly inspect exhaust motors and belts for proper function, repair and replace as necessary.
4. Remove all blockages from univents and exhaust vents.
5. Once both the fresh air supply and exhaust ventilation are functioning, the ventilation system should be balanced.
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
7. Extend wire bird screens installed on exhaust vents to fit flush with vent housing or cover existing spaces with wire mesh to prevent egress.
8. Inspect all rooftop vents regularly for integrity and repair as needed. Consider numbering vents and create a checklist for maintenance personnel to sign off on.

9. Replace any remaining water-stained ceiling tiles, wall plaster and building materials. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.

10. Move plants away from univents in classrooms. Ensure plants have drip pans and examine drip pans for mold growth. Disinfect with an appropriate antimicrobial where necessary. Remove foliage at least five feet away from the foundation.

11. Replace missing ceiling tiles and fill open utility holes/wall cracks to prevent the egress of dirt, dust and particulate matter into classrooms.

12. Consider ducting wood dust collector in the woodshop to the outdoors to prevent the aerosolization of small diameter wood dust. Adopt scrupulous cleaning practices (i.e. wet wiping) to minimize irritant effects caused by aerosolized particulates (eye, throat and sinus irritations).

13. Replace/repair woodshop door to prevent woodshop odors from penetrating into adjacent areas of the school.

14. Ascertain whether crumbling material inside the kiln in Picture 23, contains asbestos and encapsulate or dispose of in an appropriate manner consistent with Massachusetts hazardous waste laws.

15. Have a chemical inventory done in all storage areas and classrooms. Properly store flammable materials in a manner consistent with the local fire code. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Label chemical containers with the chemical name of its contents. Follow proper procedures for storing and securing hazardous materials.

16. Obtain Material Safety Data Sheets (MSDS) for chemicals from manufacturers or suppliers. Maintain these MSDS' and train individuals in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).
17. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.
18. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
19. Restore restroom exhaust ventilation. Clean vents periodically of accumulated dust and debris to ensure proper airflow.

The following **long-term** measures should be considered.

1. Prior to any repair of the building envelope, the following evaluations should be considered:
    a. An examination of water drainage beneath the foundation on the structure of the building.
    b. An examination by a civil and/or building engineer of the best method to redirect water away from the foundation of the MVMMS. This evaluation should include an analysis on how the concrete walkway can be redesigned to aid water drainage from the foundation of the building. Methods that may be used are:

i. Improving the grading of the ground away from the foundation at a rate of 6 inches per every 10 feet (Lstiburek, J. & Brennan, T.; 2001).

ii. Installation of a water impermeable layer on ground surface (clay cap) to prevent water saturation of ground near foundation (Lstiburek, J. & Brennan, T.; 2001).

c. An examination of possible methods to prevent flooding from Ell Pond. This should include an examination of the feasibility of constructing a levee to prevent floodwaters from reaching the building.

2. Consider having exterior brick re-pointed and/or waterproofed to prevent further water intrusion. During this re-pointing project it is recommended that all water-damaged materials be examined for microbial growth and structural integrity. Repair water damaged ceilings, walls and wall-plaster as necessary. In addition, weatherproofing materials should be applied during periods when the school is not occupied.

3. Based on the age, physical deterioration and availability of parts of the HVAC system, the BEHA strongly recommends that the HVAC engineering firm fully evaluate the ventilation system for repair/replacement considerations.

4. Repair/replace broken and/or loose windows and replace missing or damaged window caulking to prevent water penetration through window frames.

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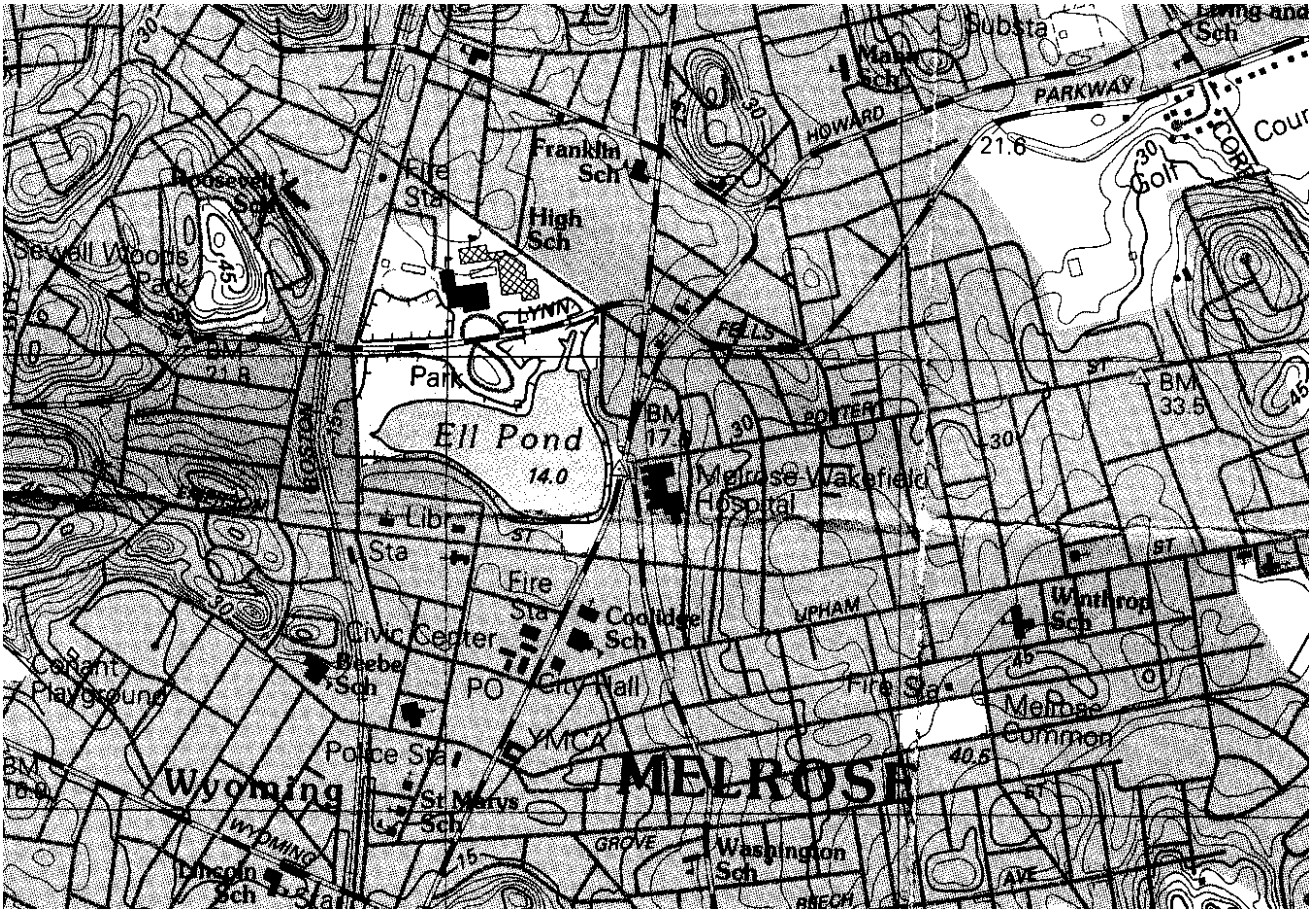
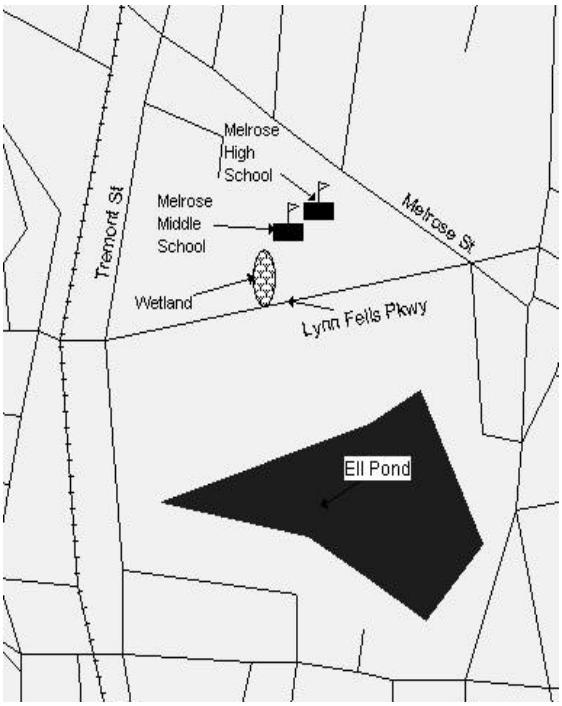
Map 1

Topographical Layout of Melrose Middle School Area



Map 2
Wetland and Its Proximity to Melrose Middle School



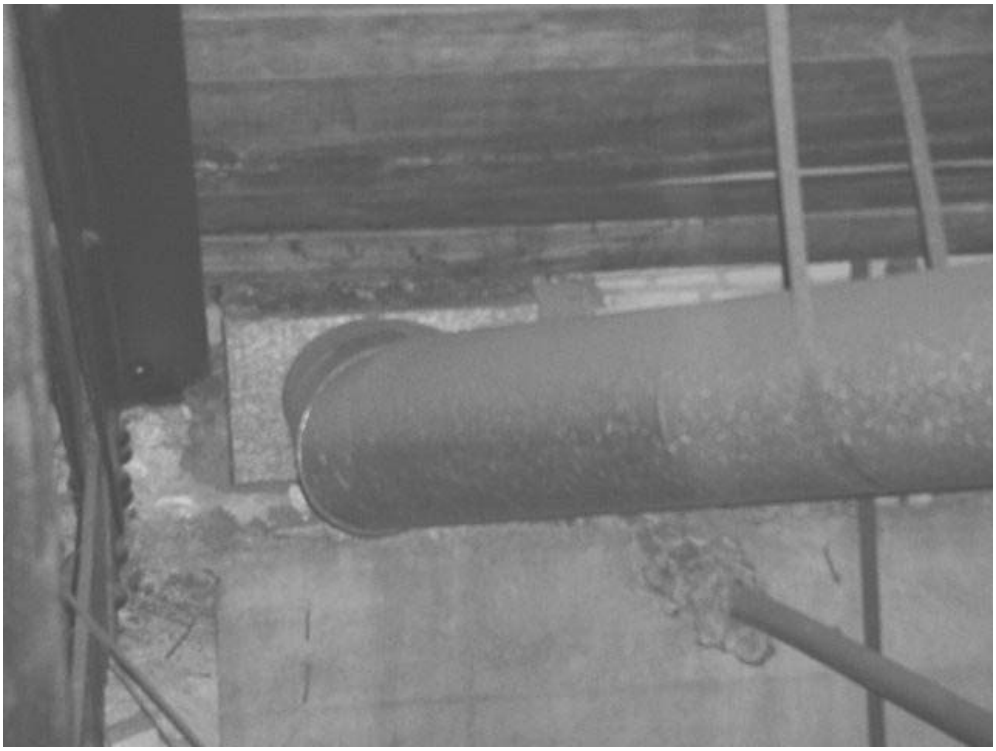
(Map Not to Scale)

Picture 1.

Univent Air Intake Vent

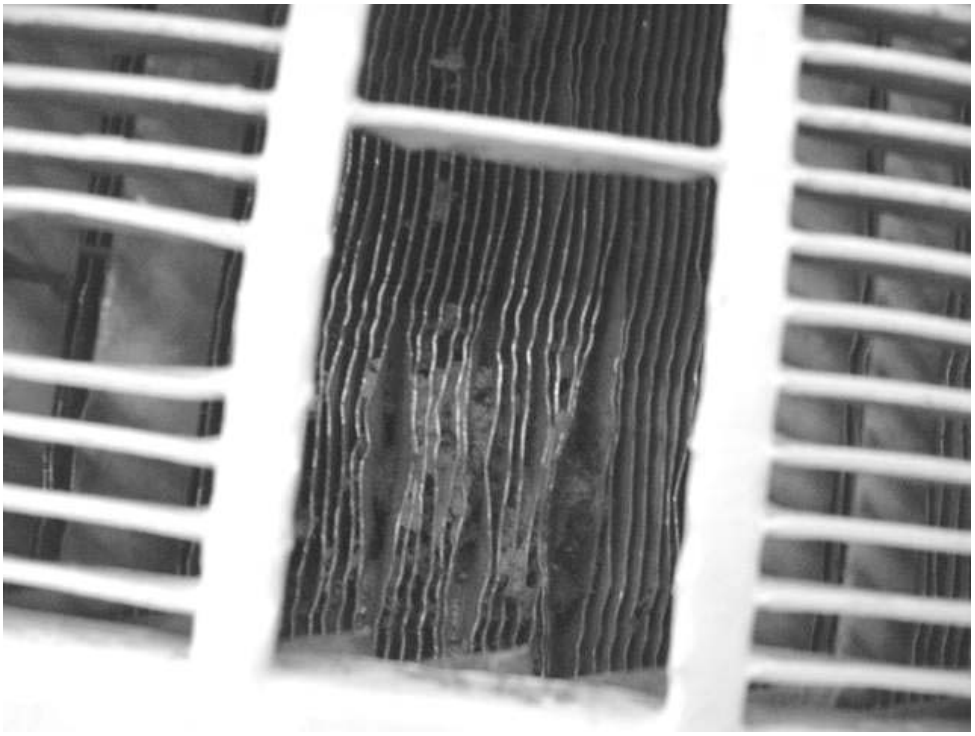
Penthouse Containing Supply Ductwork for Univent System

Picture 2



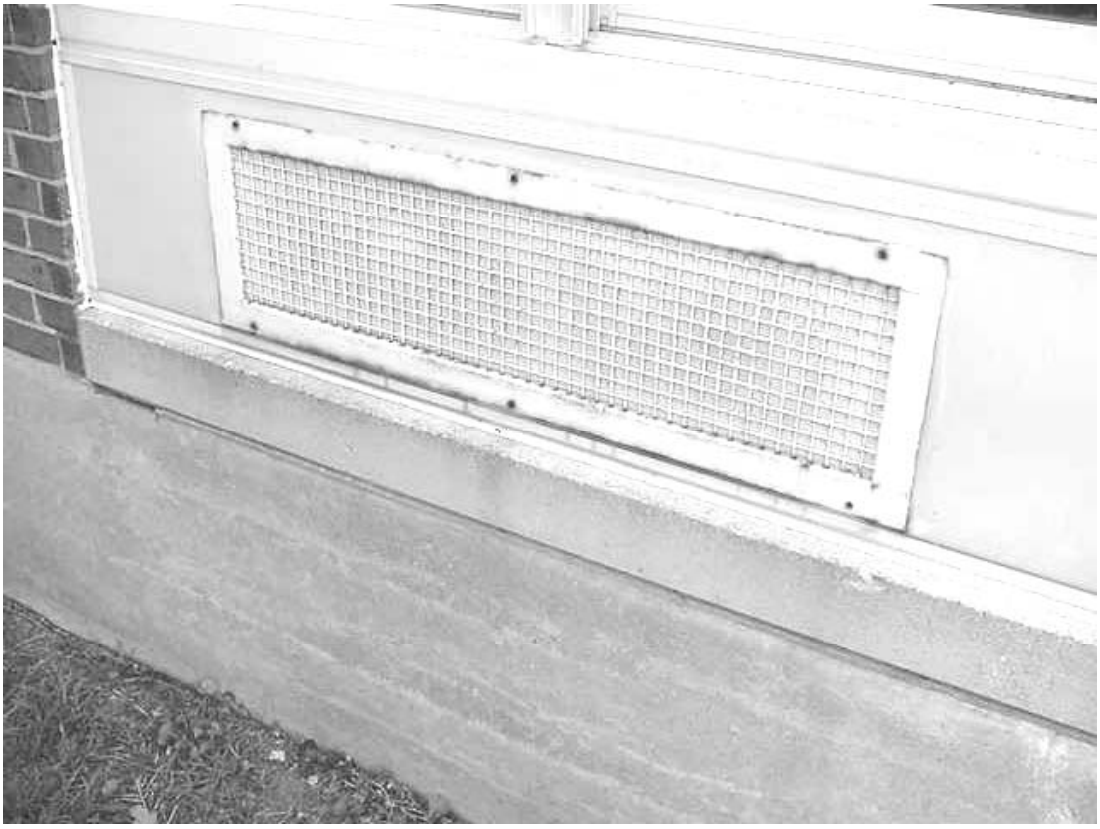
Univent Supply Ductwork Connected to Intake Vent in Previous Picture

Picture 3



Missing/Damaged Univent Air Diffuser and Heating Fins,
Note Accumulated Debris between Heating Fins

Picture 4



Univent Air Intake, Sealed with Plywood

Picture 5

Obstructed Exhaust Vent

Picture 6

Hole at Foundation of Melrose Middle School Building

Picture 7

Hole at Foundation of MMS Building

Picture 8

Wetland Southwest of MMS

Picture 9

Approximately 3-4” of Standing Water on Boiler Room Floor

Picture 10

Water Damaged Wall Plaster and Efflorescence Near Windows

Picture 11

Water Damage in Exhaust Vent

Picture 12

Water Damaged Ceiling Tiles in Annex Walkway

Picture 13

Shrubbery in Close Proximity to Building

Picture 14

Missing/Damaged Window Caulking

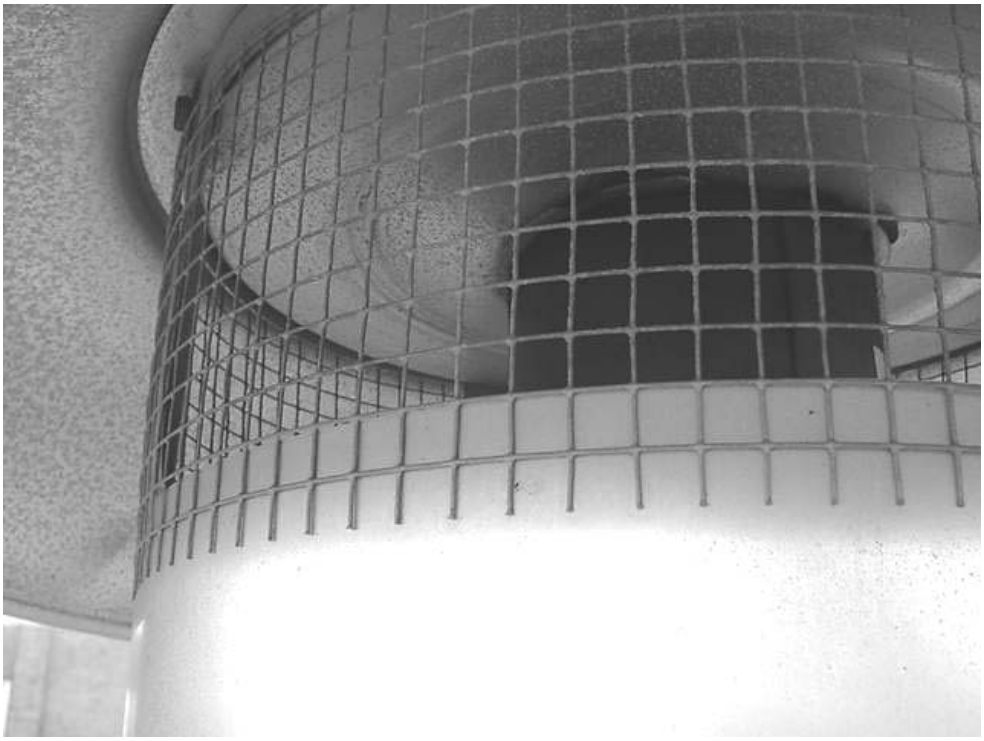
Picture 15

Windows Frames Sealed with Duct Tape (Missing Damaged Caulking)

Picture 16

Standing Water and Accumulated Debris in Trough on Roof,

Picture 17



Rooftop Exhaust Vent Bird Screen, Note Screen Overlaps Housing

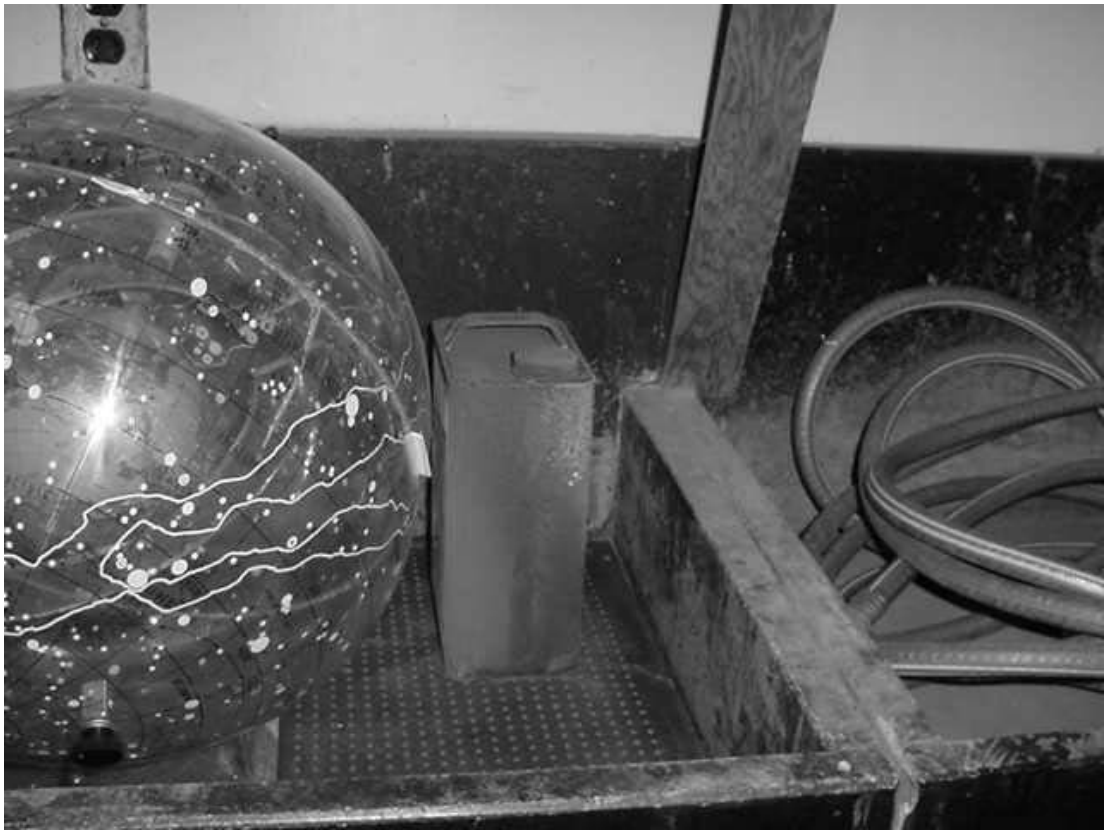
Picture 18

Rooftop Exhaust Vent Bird Screen, Note Gaps between Screen and Housing

Picture 19

Old Materials Stored beneath Desk in Abandoned Shop Area

Picture 20



Rusted/Corroded Container of Paint Thinner

Picture 21

Interior of Flammable Cabinet, Note Corroded Walls and Shelving and Crystallized Material on Shelf

Picture 22

Unused Kiln in Art Room – Note Proximity to Univent

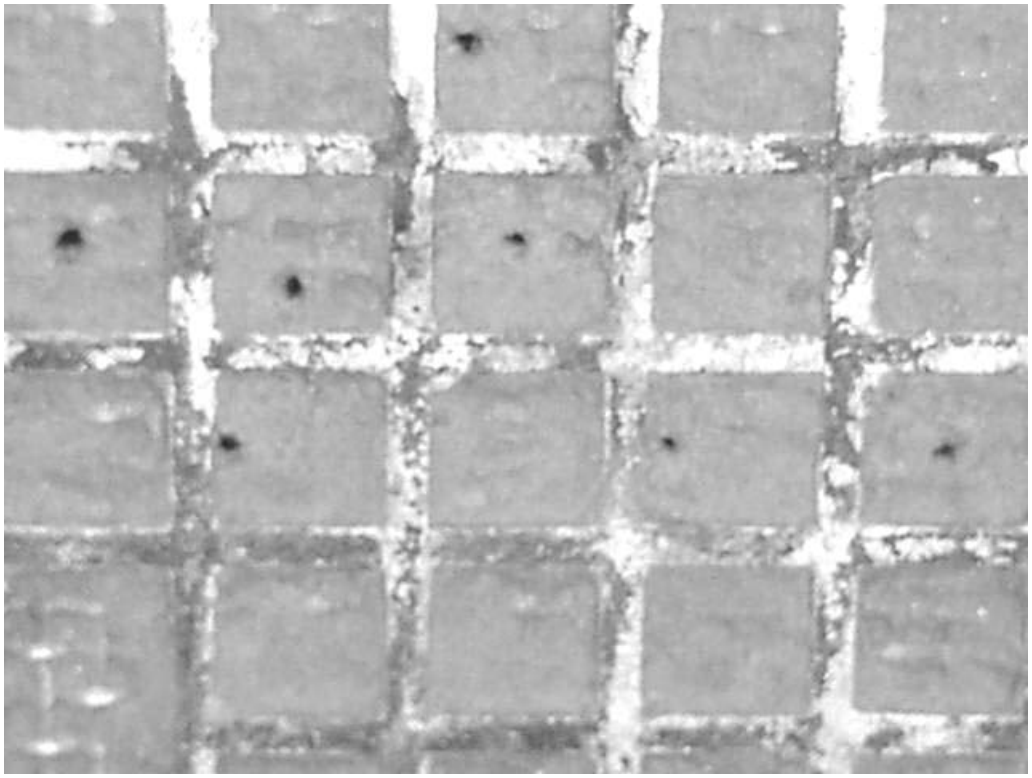
Picture 23

Close Up of Art Room Kiln shown in Picture 22

Picture 24

Accumulated Items in Classroom

Picture 25



Close-Up of Restroom Exhaust Vent Occluded with Dust and Debris

Picture 26

Restroom Exhaust Vent Sealed With Sheet Metal

TABLE 1

Indoor Air Test Results – Melrose Middle School, Melrose, MA – March 26, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	307	40	49					Weather conditions: windy
Room 34	1484	67	37	9	Yes	Yes	Yes	Books on univent, exhaust off-backdraft, missing/damaged caulking, chalk dust
Room 33	1148	67	32	21	Yes	Yes	Yes	Univent off, window open, missing/damaged caulking,
Room 32	1455	68	34	16	Yes	Yes	Yes	Univent and exhaust off, exhaust backdrafting, personal fan, dry erase board, accumulated items
Room 31	1755	70	35	21	Yes	Yes	Yes	Exhaust off-backdraft, 6 computers, dry erase board, accumulated items
Room 36	1244	68	31	1	Yes	Yes	Yes	Rubber cement thinner, spray adhesive, kiln, reported burst pipe flooded room few years prior, water cooler, storage area flooded previous year-backed up
Room 28	2040	67	34	18	Yes	Yes	Yes	5 computers
Room 27	1647	70	33	20	Yes	Yes	Yes	Exhaust off-backdraft, chalk dust
Room 26	1931	69	33	6	Yes	Yes	Yes	(24) occupants gone <5 min., books/papers on univent

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – Melrose Middle School, Melrose, MA – March 26, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 14 – Gately	1125	65	30	0	Yes	Yes	Yes	Exhaust off, carpet
Room 14 – Douglas	978	67	31	0	Yes	No	No	Sub-divided room, dry erase board, carpet, door open
Room 21	1943	70	31	19	Yes	Yes	Yes	Items on univent-univent fan off, exhaust off, accumulated items
Room 25	2062	70	35	20	Yes	Yes	Yes	Broken window pane
Small Office 25/26	1576	68	31	0	Yes	No	No	
Room 15A	1105	68	30	0	Yes	Yes	Yes	Items on univent, exhaust vent near door-off-backdraft
Room 15B	1301	68	31	3	Yes	No	No	Rooms 15 A/B divided-ventilation on A side, door open
Administrator's Office	1185	68	30	0	Yes	No	No	Door open
Room 16	872	66	27	0	No	Yes	Yes	
Room 11	911	65	28	0	Yes	No	No	

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Melrose Middle School, Melrose, MA – March 26, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Multi-Disability Classroom	1255	71	30	8	Yes	Yes	Yes	Items on/around univent, window-mounted air conditioner-filter dirty, exhaust partially blocked/off/backdraft, ceiling fans, temperature extremes reported
Roof Notes								6 exhaust fans-2 not operating, classroom fans, gaps in screens
Room 38 (Art)	1310	66	32	19	Yes	Yes	Yes	Dust/debris build-up in radiators, exhaust vent in storage closet office, accumulated items
Room 35	1063	66	31	0	Yes	Yes	Yes	Items on univent-little airflow, radiator fins occluded with dust/debris, exhaust blocked by bookcase/cabinet (office), chalk dust
Boy's Restroom					Yes	No	Yes	
Room 24	1600	68	34	20	Yes	Yes	Yes	Exhaust off
Room 23	1860	70	34	26	Yes	Yes	Yes	5 plants with drip pans, chalk dust, exhaust off
Room 22	1710	73	32	14	Yes	Yes	Yes	Chemical/perfume odor, exhaust off

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Melrose Middle School, Melrose, MA – March 26, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
School Councilor	1246	69	31	2	Yes	No	Yes	Window-mounted air conditioner-fan only option, temperature complaints-cold, room divided-no vent, ceiling fan
Room 13	1152	68	30	5	Yes	Yes	Yes	Exhaust off-backdraft, carpet stains, refrigerator, ceiling fans, window-mounted air conditioner
Vocational/Art Room	1052	65	29	0	No	Yes	Yes	Ceiling-mounted vents, dehumidifier-standing water, reported flooding in area
Vocational/Therapy Room	967	65	30	0	No	Yes	Yes	Ceiling vents-switch activated, carpet
Girl's Restroom					Yes	No	Yes	Exhaust weak, floor drain
Bridge to Annex								Water damage-duct tape as caulking, burlap insulation
Main Building								
Room 407	1681	70	35	0	Yes	Yes	Yes	Exhaust blocked by cabinet, 6 computers, door open
Room 408	1441	71	33	0		Yes	Yes	Chalk dust, door open

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results – Melrose Middle School, Melrose, MA – March 26, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 409	1460	71	33	14	Yes	Yes	Yes	Exhaust blocked by display board, (3) emergancy showers, flammables cabinet-acids/corrosives
Room 410	1663	72	33	19	Yes	Yes	Yes	Water damage around exhaust vent, (3) showers, dry erase board
Room 411	1631	73	34	25	Yes	Yes	Yes	Wall cracks-closet, acid/ethanol under sink, 6 computers, (3) showers
Room 412	1406	72	31	22	Yes	Yes	Yes	Window open, chalk dust, dry erase board
Room 412 Office	1291	71	31	0	Yes			Peeling paint, door open
Room 401	1299	71	31	20	Yes	Yes	Yes	Boxes obstructing univent, personal fan, door open
Room 416	1172	70	30	0	Yes	No	No	Door pen
Room 418	976	69	33	0	Yes	No	Yes	Dry erase board
Room 402	1313	70	35	20	Yes	Yes	Yes	5 computers, personal fan, cleaning product, door open
Room 403	1892	72	37	19	Yes	Yes	Yes	Exhaust off, chalk dust, plants
Library	769	66	28	19	No	Yes	Yes	58º F in hallway

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CT = ceiling tiles

Comfort Guidelines

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	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results – Melrose Middle School, Melrose, MA – March 26, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 415	1683	70	34	25	Yes	Yes	Yes	Window open, paint chips/debris on windowsill, chalk dust
Room 414	1720	71	34	19	Yes	Yes	Yes	Reported odors when windows are open-skunk-like/rubbish
Room 413	913	69	30	0	Yes	Yes	Yes	5 water-damaged CT, no air flow from univent, strong draft from window, water-damaged plaster, efflorescence around storeroom window, chalk dust, pencil shavings
Room 404	2180	72	40	18	Yes	Yes	Yes	Chalk dust
Room 405	1838	71	37	16	Yes	Yes	Yes	Door open

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Comfort Guidelines

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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 7

Indoor Air Test Results – Melrose Middle School, Melrose, MA – April 23, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	369	53	35					Weather conditions: cloudy/overcast
Nurse's Office	1122	68	45	7	Yes	Yes	Yes	Univent off, exhaust off/blocked/backdraft, ~30 plants-some with paper plate drip pans
Men's Teacher's Room	951	69	35	0	Yes	No	No	3 broken windows, peeling paint
Room 302	1875	71	41	14	Yes	Yes	Yes	Univent off, exhaust off/backdraft, 4 computers, 2 personal fans, dry erase board, chalk dust
Room 301	1649	71	39	25	Yes	Yes	Yes	Univent off-drafts from around univent, exhaust off/backdraft, door open, chalk dust
Room 315	1575	71	38	31	Yes	Yes	Yes	Univent and exhaust off, 5 computers, accumulated items, door open, turtle, aquarium, mold experiment, sinks
Room 314	1733	71	36	15	Yes	Yes	Yes	Many plants, taxidermy examples, aquarium-sponge, 6 computers, personal fan, accumulated items, door open, utility holes

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 8

Indoor Air Test Results – Melrose Middle School, Melrose, MA – April 23, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 3112	2071	71	38	17	Yes	Yes	Yes	Univent and exhaust off, peeling paint-especially around windows, personal fan, chalk dust
Storeroom	1094	69	33	0	Yes	No	No	Utility holes, butane fuel canister, moldy items in plastic bag
Room 311	1677	70	38	24	Yes	Yes	Yes	Univent and exhaust off, door open, accumulated items, 5 computers
Room 310 – Office	1400	69	39	2	Yes	No	Yes	5 plants, 2 photocopiers
Assistant Principal's Office	1373	68	40	1	Yes	No	No	Personal fan, 2 plants, peeling paint-ceiling corner
Room 309	1308	68	37	0	Yes	Yes	Yes	2 door open, dry erase board
Room 308	1777	70	41	19	Yes	Yes	Yes	Exhaust off, water-damage-corner
Room 307	3091	71	46	27	Yes	Yes	Yes	Window open, 6 computers, personal fan, water-damage-corner, chalk dust
Room 306	2210	71	41	25	Yes	Yes	Yes	Window open, water cooler, falling ceiling, chalk dust

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 9

Indoor Air Test Results – Melrose Middle School, Melrose, MA – April 23, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Previous Nurse's Office	1075	69	35	0	Yes	No	No	
Room 305	1853	69	35	0	Yes	No	No	
Cafeteria	720	69	37	~275	Yes	Yes	Yes	Floor fans
Boiler room								Door open, exterior door, water on floor
Custodian's Office	620	70	32	0	Yes	No	No	Plaster cracks
Room 108	621	68	30	0	Yes	Yes	Yes	Window open, 6 gas stoves-not vented, hole in wall, rock salt, bees/bugs on windowsill
Faculty Lounge	915	67	36	9	Yes	Yes		Sink, spray cleaner
Meeting Room	1049	68	37	0	Yes	Yes	No	
Room 206	1190	69	38	21	Yes	Yes	Yes	Exhaust cubby –used for trash storage, univent and exhasut off, plants on univent, door open
Room 205	694	68	34	0	Yes	No	No	Open window in offices

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Comfort Guidelines

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 10

Indoor Air Test Results – Melrose Middle School, Melrose, MA – April 23, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 205B	711	68	34	0	Yes	No	No	Second office
Room 205D	680	68	34	0	Yes	No	No	Water-damaged ceiling plaster, storeroom
Main Office	814	69	32	2	Yes	No	No	Hole in floor-Ms. Anderson's area, (2) window-mounted air conditioners-filters could not be checked due to height, photocopier, lamination machine, other office equipment – no local exhaust, plants
Room 202	768	70	35	0	No	No	Yes	Small room off main office, exhaust off, 3 photocopiers
Guidance Office	852	68	33	1	Yes	No	No	Passive vents in wall to distribute air from offices to main room
Women's Faculty Restroom	651	66	30	0	Yes	No	Yes	Exhaust weak, reports of bird feathers from exhaust vent-grill could not be removed due to dried paint-bird feather on floor below exhaust vent
Room 209	1092	65	39	6	Yes	Yes	Yes	Ventilation system off

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Comfort Guidelines

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 11

Indoor Air Test Results – Melrose Middle School, Melrose, MA – April 23, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 203 (Computer Room)	985	67	36	14	Yes	No	No	20+ computers, heat complaints, no air conditioner, no ventilation system, (similar to 204)
Handicapped Stairwell								Large space between woodshop doors-woodshop odors-wood dust
Gym	792	65	37	26	Yes	Yes	Yes	Ventilation system off
Ms. Florerke Office	1189	67	40	13	Yes	Yes	Yes	Ventilation system off
2nd Floor Men's Restroom	541	64	35	0	Yes	No	Yes	Exhaust weak-clogged/sealed vents
Room 213	589	67	34	1	Yes	Yes	Yes	Univent and exhaust off, exposed fiberglass around univent, 4 plants
Room 211	618	66	34	0	Yes	Yes	Yes	Univent and exhaust off, water damaged around windows/frames-efflorescence
Room 210	925	67	35	6	Yes	Yes	Yes	Exhaust vent blocked by bookcase, univent and exhaust off
Room 208	1433	69	41	20	Yes	Yes	Yes	Exhaust-cubby used for storage, univent and exhaust off, 2 plants

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Comfort Guidelines

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 12

Indoor Air Test Results – Melrose Middle School, Melrose, MA – April 23, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
1st Floor Roof-Outside Rooms 207/208								Pooling water, decaying leaves/debris
Room 207	1467	69	41	25	Yes	Yes	Yes	Door open, chalk dust, univent diffuser on backward-directing air toward wall, water-damaged ceiling plaster, univent and exhaust off
Electrical Shop	1681	68	39	14	Yes	Yes	Yes	Drill press, soldering, univent air intake sealed with plywood, chalk dust
Room 106	930	68	36	1	Yes	Yes	Yes	5 computers, (6) occupants gone ~45 min., 7 plants, chalk dust, ceiling tile ajar
Room 105	1172	68	41	10	Yes	Yes	Yes	8 plants, bugs on windowsill, chalk dust
Office	1199	69	38	0	Yes	No	No	
Room 103	1175	70	38	9	Yes	Yes	Yes	Computers, soda cans in cardboard box, adhesive, sander
Room 104	1203	69	39	9	Yes	Yes	Yes	Exhaust blocked, 2 computers, chalk dust

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 13

Indoor Air Test Results – Melrose Middle School, Melrose, MA – April 23, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 102	1164	69	37	0	Yes	Yes	Yes	Plant, chalk dust
Woodshop	652	65	31	0	Yes	Yes	Yes	Dust collector, wood stains, accumulated wood dust, 5 broken windows
Girl's Locker Room	938	66	37	0	No	Yes	Yes	Supply on, exhaust off, 2 doors open, floor drains
Outside – end of day	409	48	31					
Perimeter Notes								Annex bldg.-broken block-style windows, Main bldg.-sink holes, missing/damaged caulking, some univent air intakes sealed (e.g. 2 cafeteria intakes),
Rooftop-Original Building								Abandoned exhaust vents for lab hoods-hoods were removed, exhaust fan #3 not operating-provides general exhaust for main bldg.

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%